EFFECT OF FOREST HUMUS ON PARASITIC FUNGI CAUSING DAMPING-OFF DISEASE OF CONIFEROUS SEEDLINGS [1]

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Earlier observations have indicated that application of acid peat and morlike humus to nursery soils has a tendency to reduce damping-off disease (6; 8, p. 202; 9, 10). It was suggested also that especially severe attacks of parasitic fungi occur on nursery soils depleted in organic matter, and some foresters believe that damping-off disease can be controlled by the enrichment of soil in humus through the use of green manure crops (2). The present study aimed to test the validity of these observations by systematic greenhouse experiments and pure culture trials in the Soils Department, University of Wisconsin.

The growing media in greenhouse pot cultures consisted of a 1:1 mixture of quartz sand and and A_1 horizon of outwash sand (Plainfield series), pH 5.65, infested primarily with *Pythium irregulare* Buisman and *Rhizoctonia solani* Kühn (5). This mixture was treated with shredded humus material at the rate of 0.8, 1.6, and 3.2 per cent by weight, oven-dry basis. The humus was collected in virgin stands of the Menominee Indian Reservation, Wisconsin. It included partly decomposed organic debris (F + H horizon) of the same *friable mor* type, originated from the following forest covers: 1) white pine and red pine of *Gaultheria-Vaccinium-Maianthemum* association; 2) hemlock–yellow birch of *Clintonia-Lycopodium* association; 3) American beech of *Smilacina-Polygonatum* association. The reaction of organic debris of all origins varied between pH 5.2 and pH 5.5, depending upon the individual sample.

The treated soils were placed in subirrigated 1-qt. porous clay pots, and seeded with 50 jack pine seeds per pot, December 30, 1950. After 30 days the survived seedlings were removed from the jars and the soils were immediately replanted to pine seed. The same procedure was repeated twice at 30-day intervals.

Because the experiment included nine humus-treated cultures and was repeated four times, duplicate jars were not used except for check cultures which were run in triplicate. Records of survived seedlings were taken at regular intervals. Percentages of living seedlings in each culture 20 and 30 days after seeding are in table 1.

Although the intensity of the disease varied considerably at different times, the trials strikingly demonstrated the remedial effect of humus of this particular morphological type. Addition of humus at a reasonably high rate reduced seedling loss approximately 100 per cent. Results with untreated soils illustrate the erratic behavior of pathogens. Since the moisture content was kept constant in subirrigated cultures, this behavior may be attributed to occasional differences in greenhouse temperature, as suggested by Leach (1) and Wakeley (7).

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TABLE 1.—*Survival of jack pine seedlings 20 and 30 days after seeding in soils with different contents of forest humus*

Type of humus and application rate, in per cent by weight	Percentage survival (20 days–30 days) Seeding 1	2	3	4	Average	Soil pH at end of experiment
Check, no humus	0– 0	35– 3	92–81	40– 7	42–23	5.6
White pine–red pine duff						
0.8	10– 0	57–23	100–98	92–22	65–36	5.4
1.6	24– 4	59–21	94–90	96–33	67–37	5.3
3.2	25– 6	66–31	100–100	100–50	73–47	5.2
Hemlock–yellow birch duff						
0.8	6– 0	88–86	97–97	100–24	73–52	5.3
1.6	25– 3	87–81	79–40	96–17	72–35	5.2
3.2	51–16	95–88	97–92	92–27	84–56	5.1
Beech duff						
0.8	8– 4	51–15	100–100	91–29	62–37	5.5
1.6	15– 3	82–42	60–49	86–38	61–33	5.5
3.2	31–11	83–51	89–89	82–43	71–48	5.5

In order to determine whether or not forest humus has antibiotic or growth-inhibiting substances, *Pythium ultimum* and *Rhizoctonia solani* were grown in synthetic media with and without humus extracts. Pure cultures of these fungi were obtained from the Division of Forest Pathology, U. S. Department of Agriculture, Washington, D. C., and synthetic media as recommended by Lindeberg (3) and Melin (4) were used. Humus extracts were prepared by placing 100 gm. of air-dry organic material in 500 ml. of distilled water, allowing the suspensions to stand for 24 hr. in a refrigerator, and then filtering them through a Buechner funnel. The extracts contained about 3 mgm. of dry matter per ml. The fungi were grown in liquid media and on agar plates.

Less than 5 ml. of humus extracts per culture did not inhibit growth of either *Rhizoctonia solani* or *Pythium ultimum*. In fact, growth of *Rhizoctonia* was stimulated at the relatively high concentration of 5 ml. of extracts per 10 ml. of nutrient solution. Growth of *Pythium*, however, was retarded by addition of 5 ml. of humus extract per plate (Table 2).

TABLE 2.—*Effect of humus extract on the growth of Pythium ultimum on agar media (5 ml. humus extract per 10 ml. of agar)*

Type of humus extract	Diameter of colony (mm.) after: 15 hr.	24 hr.
Check	30.8	57.6
White pine–red pine mor	13.1	34.6
Hemlock–yellow birch mor	5.4	20.8
Beech mor	14.0	43.2

Results of greenhouse trials confirm early observations that treatment of soil with forest humus moderates the intensity of damping-off disease. On the other hand, the pure-culture trials suggest that the beneficial effect of the addition of humus is not necessarily due to the presence of a specific antibiotic substance. The slight degree of acidification, achieved at the end of the experiment, indicates that the reaction of the medium in this particular case is of little significance as a factor controlling disease. Since seedlings invariably show much better growth in humus-treated soils, it is reasonable to assume that the remedial effect of humus is largely due to the release of readily available nutrients that strengthen the tissue of young roots and thus shorten the period of seedlings' susceptibility to disease. Perhaps the designation of damping-off disease by German practitioners as "Bodenmüdigkeit" or "soil tiredness" (2, p. 438) has a certain degree of justification.

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